EXHIBIT 26

American National Standard

for Telecommunications –

Network and Customer Installation Interfaces – Asymmetric Digital Subscriber Line (ADSL) Metallic Interface

DEVELOPED BY
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ANSI T1.413-1998

9.6 Channel analysis (ATU-C)

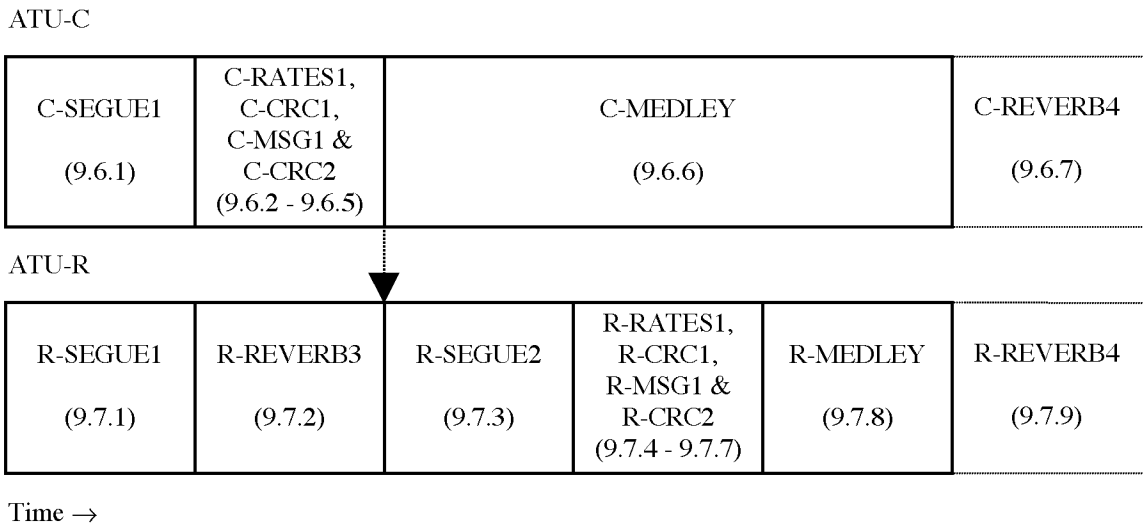

Figure 41 - Timing diagram of channel analysis (9.6-9.7)

During channel analysis the synchronization between ATU-C and ATU-R may be broken during R-REVERB3, which has an indefinite duration; this potential timeout is described in 9.7.2. Furthermore, if during channel analysis any CRC check sum indicates an error in any of the control data, this shall trigger a reset to C-QUIET1.

9.6.1 C-SEGUE1

Except for the pilot tone, C-SEGUE1 shall be generated from a tone-by-tone 180 degree phase reversal of C-REVERB1 (i.e. + maps to -, and - maps to +, for each of the 4-QAM signal constellation). The duration of C-SEGUE1 is 10 (repeating) symbol periods. Following C-SEGUE1, ATU-C enters state C-RATES1.

9.6.2 C-RATES1

C-RATES1 is the first ATU-C signal for which a cyclic prefix (defined in 6.12) is used. The purpose of C-RATES1 is to transmit four options for data rates and formats to the ATU-R. Each option consists of three fields:

– B_F lists the number of bytes in the fast buffer for each of AS0, AS1, AS2, AS3, LS0, LS1, LS2, LS0 (upstream), LS1 (upstream), LS2 (upstream) channels, in that order; B_F has a total of 80 (= 10×8) bits. The first 8 bits of B_F specify the number of bytes in AS0, the second 8 bits specify the number of bytes in AS1, and so on. Each byte of B_F is transmitted with least significant bit first;

– B_I similarly lists the number of bytes in the interleaved buffer;

– {RS_F, RS_I, S, D, FS(LS2)} is a ten-byte quantity comprising (one byte each)

– the RS_F field, containing RS_F, the number of parity bytes per symbol in the downstream fast buffer, with $0 \le RS_F \le 63$ and RS_F equal to R_F (see Figure 13);

– the RS_I field, containing the value of RS_I , the number of parity bytes per symbol in the downstream interleave buffer, with $0 \le RS_I \le 63$ and RS_I equal to R_I / S (see Figure 14);

– the S field, containing the value of S, the number of symbols per codeword (downstream), with $0 \le S \le 63$;

– the D field, containing the downstream interleave depth in codewords, with $0 \le D \le 128$;

– the FS(LS2) field is a field of eight zeros;

– the same five quantities {RS_F, RS_I, S,D,FS(LS2)} in the upstream direction (one byte each, in that order).

The four options are transmitted in order of decreasing preference. C-RATES 1 is preceded by a 4-byte prefix of {01010101 01010101 01010101 01010101}. Table 27 summarizes C-RATES1.

Table 27 - C-RATES1

		Option 1			Option 2			Option 3			Option 4		
	Prefix	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*
Nr of bytes	4	10	10	10	10	10	10	10	10	10	10	10	10

Only one bit of information is transmitted in each symbol of C-RATES1: a zero bit is encoded to one symbol of C-REVERB1 and a one bit is encoded to one symbol of C-SEGUE1. Since there are a total of 992 bits of C-RATES1 information, the duration of C-RATES1 is 992 symbols. The 992 bits are to be transmitted in the order shown in Table 27 , with the least significant bit first. That is, the least significant bit of option 1, B_F, is to be transmitted during the 33rd symbol of C-RATES1, after the prefix. Following C-RATES1, the ATU-C shall enter state C-CRC1.

9.6.3 C-CRC1

C-CRC1 is a cyclic redundancy check for detection of errors in the reception of C-RATES1 at the ATU-R. The CRC bits are computed from the C-RATES1 bits using the equation:

$c(D) = a(D)\ D^{16}$ modulo g(D),

where

$a(D) = a_0\ D^{959} + a_1\ D^{958} \ldots + a_{959}$ is the message polynomial formed from the 960 bits of C-RATES1, with a_0 the least significant bit of the first byte of C-RATES1 (i.e., option 1 B_F);

$g(D) = D^{16} + D^{12} + D^5 + 1$ is the CRC generator polynomial, and

$c(D) = c_0 D^{15} + c_1 D^{14} \ldots\ldots + c_{14} D + c_{15}$ is the CRC check polynomial.

The 16 bits c_0-c_{15} are transmitted (c_0 first and c_{15} last) in 16 symbol periods using the method described in 9.6.2. Following C-CRC1, the ATU-C shall enter state C-MSGS1.

9.6.4 C-MSGS1

C-MSGS1 transmits a 48-bit message signal to the ATU-R. This message includes vendor identification, ATU-C transmit power level used, trellis coding option, echo cancelling option, etc. The message, *m*, is defined by:

$$m = \{m_{47}, m_{46}, \ldots\ldots m_1, m_0\}$$

with m_0 being transmitted first. The message components are defined in the following sub-clauses, and their assigned positions within the composite message, *m,* are defined in Table 28.

A total of 48 symbol periods are used to communicate the 48-bit message, using the encoding method described in 9.6.2. Following C-MSGS1, the ATU-C shall enter signaling state C-CRC2.

Table 28 - Assignment of 48 bits of C-MSGS1

Suffix(ces) of m_i	Parameter
47-44 (see note 1)	Minimum required SNR margin; see note 2
43-28	Vendor identification
27-26	Reserved for future use; see note 3
25-23	T1.413 revision number
22-18	Vendor revision number
17	Trellis coding option
16	Echo canceling option
15	Expanded exchange sequence
14	Reserved for future use; see note 3
13-12	Set to {00}; see note 4
11	Network timing reference
10-9	Framing structure
8-6	Transmit PSD during initialization
5-4	Reserved for future use; see note 3
3-0	Maximum numbers of bits per sub-carrier supported

NOTES

1. Within the separate fields the least significant bits have the lowest subscripts.
2. A positive number of dB; binary coded 0-15 dB.
3. All bits "reserved for future use" shall be set to 0 until defined.
4. Power boost is not allowed in Issue 2 transceivers; therefore the {00}, which indicated -40 dBm/Hz in Issue 1 transceivers, shall be used.

9.6.4.1 Minimum required SNR margin - bits 47 - 44

Binary coded 0 to 15 dB

9.6.4.2 Vendor identification - bits 43 - 28

The vendor ID is coded in binary. The currently assigned vendor ID's are listed in Annex D. Others may be added in the future.

9.6.4.3 T1.413 revision number - bits 25 - 23

For ATU's complying with ANSI T1.413 Issue 2, the revision number shall be coded {001}.

NOTE - This is consistent with the three most significant bits of the revision number of a ANSI T1.413 Issue 1 ATU being set to {000}.

9.6.4.4 Vendor revision number - Bits 22-18

To facilitate upgrades in the future, five bits are reserved to allow any vendor to include a revision number for each unit. When an ATU-C connects to an ATU-R with the same vendor ID, this may serve to simplify upgrades, diagnostics, maintenance, etc.

9.6.4.5 Trellis coding option - Bit 17

m_{17} = 0 indicates no trellis coding capability, m_{17} = 1 indicates trellis coding capability.

9.6.4.6 Echo cancellation option - Bit 16

m_{16} = 0 indicates no echo cancellation, m_{16} = 1 indicates echo cancellation.

9.6.4.7 Expanded exchange sequence - Bit 15

The extended exchange sequence shall be enabled (bit 15 = 1). The extended exchange sequence shall be used if and only if both ATU's indicate bit 15 = 1.

9.6.4.8 NTR - Bit 11

m_{11} = 1 indicates that the ATU-C will use indicator bits ib23 to ib 20 as defined in 6.3.2.

9.6.4.9 Framing structure - Bits 10,9

Indicates the highest framing structure supported by the ATU-C (see 6.4). The lowest framing structure indicated by the ATU-C or ATU-R shall be used.

9.6.4.10 Transmit PSD during initialization - Bits 8,7,6

The ATU-C shall report the level of C-REVERB1 chosen as a result of the calculation described in 9.4.6. The encoding rules for m_8, m_7, m_6 are shown in Table 29.

Table 29 - C-MSG1 encoding rules for transmit PSD during C-REVERB1

m_8	m_7	m_6	PSD dBm/Hz
1	1	1	-40
1	1	0	-42
1	0	1	-44
1	0	0	-46
0	1	1	-48
0	1	0	-50
0	0	1	-52

9.6.4.11 Maximum numbers of bits per sub-carrier supported - Bits 3-0

The $N_{downmax}$ (transmit) capability shall be binary encoded onto $\{m_{3 \ldots} m_0\}$ (e.g., 1101 = 13)

The maximum number of bits for the upstream data, N_{upmax}, that the ATU-C receiver can support need not be signaled to the ATU-R; it will be implicit in the bits and gains message, C-B&G, which is transmitted after channel analysis.

9.6.5 C-CRC2

C-CRC2 is a cyclic redundancy check for detection of errors in the reception of C-MSGS1 at the ATU-R. The CRC generator polynomial is as defined in 9.6.3. The CRC message polynomial is as constructed in 9.6.3, with m_0 corresponding to a_0 and m_{47} corresponding to a_{47}. The CRC check polynomial is generated in the same way as defined in 9.6.3. These 16 bits are transmitted in 16 symbol periods using the method described in 9.6.3. Following C-CRC2, the ATU-C shall enter signaling state C-MEDLEY.

9.6.6 C-MEDLEY

C-MEDLEY is a wideband pseudo-random signal used for estimation at the ATU-R of the downstream SNR. The data to be transmitted are derived from the pseudo-random sequence, PRD, and modulated as defined in 6.11.3 and 9.4.6. In contrast to C-REVERB1, however, the cyclic prefix is used and the data sequence continues from one symbol to the next (i.e., d_1 to d_9 are not re-initialized for each symbol); since PRD is of length 511, and 512 bits are used for each symbol, the sub-carrier vector for C-MEDLEY therefore changes from one symbol period to the next. The pilot sub-carrier is over-written by the {+,+} constellation point.

Although data bits are defined for all the sub-carriers, the sub-carriers actually transmitted during C-MEDLEY shall be the same as or a subset of those transmitted during C-REVERB1 (see 6.15.1).

C-MEDLEY is transmitted for 16384 symbol periods. Following C-MEDLEY the ATU-C shall enter the state C-REVERB4.

9.6.7 C-REVERB4

C-REVERB4 is similar to C-REVERB2 (see 9.4.10), the only difference being the addition of a cyclic prefix on every symbol, and a maximum duration of 6000 symbols. C-REVERB4 continues into the exchange procedure, and its duration is not fixed. The timeout features of C-REVERB4 are defined in 9.8.1

9.7 Channel analysis (ATU-R)

During channel analysis there are two situations where the ATU-R shall reset itself to R-ACT-REQ: a timeout and a detected error in the received control data. A timeout occurs if the time in R-REVERB3 exceeds the limit of 4000 symbols. Also, if any C-CRC checksum indicates there is an error in the received control data, then it shall trigger a reset to R-ACT-REQ.

9.7.1 R-SEGUE1

Except for the pilot tone, R-SEGUE1 is generated from a tone-by-tone 180 degree phase reversal of R-REVERB1 (i.e. + maps to -, and - maps to +, for each of the 4-QAM signal constellation). The duration of R-SEGUE1 is 10 symbol periods. Following R-SEGUE1 the ATU-R shall enter state R-REVERB3.

9.7.2 R-REVERB3

R-REVERB3 is similar to R-REVERB1 (see 9.5.2); the only difference is that R-REVERB3 is the first ATU-R signal with the addition of a cyclic prefix to every symbol (defined in 7.12). The duration of R-REVERB3 is not fixed but has a maximum of 4000 symbols. If C-CRC2 is not detected within 4000 symbols the ATU-R shall timeout and reset to R-ACT-REQ. After detection of C-RATES1 - C-CRC2, the ATU-R shall continue to send R-REVERB3 for 20 additional symbols before entering R-SEGUE2.

9.7.3 R-SEGUE2

The signal R-SEGUE2 is similar to R-SEGUE1 (see 9.7.1); the only difference is the addition of the cyclic prefix. Following R-SEGUE2 the ATU-R shall enter state R-RATES1.

9.7.4 R-RATES1

Table 30 - R-RATES1

		Option 1			Option 2			Option 3			Option 4		
	Prefix	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*	B_F	B_I	*RRSD*
Nr of bytes	4	3	3	5	3	3	5	3	3	5	3	3	5

The purpose of R-RATES1 for the upstream channel is the same as that of C-RATES1 for the downstream channel (see 9.6.2). Each option consists of three fields:

– B_F lists the number of bytes in the fast buffer for each of LS0, LS1, LS2, in that order; B_F has a total of 24 (= 3 × 8) bits. The first 8 bits of B_F specify the number of bytes in LS0, the second 8 bits specify the number of bytes in LS1, and so on. Each byte of B_F is transmitted with least significant bit first;

– B_I similarly lists the number of bytes in the interleaved buffer;

– {RS_F, RS_I, *S, D, FS*(LS2)} is a five-byte quantity comprising;

– RS_F, the number of parity bytes per symbol in the fast buffer (upstream);

– RS_I, the number of parity bytes per symbol in the interleave buffer (upstream);

– *S*, the number of symbols per codeword (upstream);

– *D*, the interleave depth (upstream) in codewords for the interleave buffer;

– the *FS*(LS2) is a field of eight zeros.

The four options are transmitted in order of decreasing preference. For the present system, ATU-C has control over all the data rates, so R-RATES1 is copied from the appropriate fields of C-RATES1.

Only one bit of information is transmitted during each symbol period of R-RATES1: a zero bit is encoded to one symbol of R-REVERB1 and a one bit is encoded to one symbol of R-SEGUE1 (with addition of cyclic prefix). Since there are a total of 384 bits of RATES1 information, the length of R-RATES1 is 384 symbols. The 384 bits are to be transmitted in the order shown in Table 30 , with the least significant bit first. That is, the least significant bit of option 1, B_F (see Table 30), is to be transmitted during the 33rd symbol of R-RATES1, after the prefix. Following R-RATES1, the ATU-R shall enter state R-CRC1.

9.7.5 R-CRC1

R-CRC1 is a cyclic redundancy check intended for detection of an error in the reception of R-RATES1 at the ATU-C. The CRC polynomial c(D) and generator polynomial g(D) are the same as for C-CRC1 (see 9.6.3). The 16 bits c_0 to c_{15} are transmitted (c_0 first and c_{15} last) in 16 symbol periods using the same method as R-RATES1 (see 9.7.4). Following R-CRC1, the ATU-R shall enter state R-MSGS1.

9.7.6 R-MSGS1

R-MSGS1 transmits a 48-bit message signal to the ATU-C. This message includes vendor identification, trellis coding option, echo cancelling option, etc. The message, *m*, is defined by:

$$m = \{m_{47}, m_{46}, \ldots\ldots, m_1, m_0\}$$

with m_0, the least significant bit, being transmitted first. The message components are defined in the following subclauses, and their assigned positions within the composite message, *m,* are defined in Table 31.

A total of 48 symbol periods are used to communicate the 48 bit message, using the encoding method described in 9.7.4. Following R-MSGS1, the ATU-R shall enter signaling state R-CRC2.

Table 31 - Assignment of 48 bits of R-MSGS1

Suffix(ces) of m_i	Parameter
47-44	Reserved for future use
43-28	Vendor identification
27-26	Reserved for future use
25-23	T1.413 revision number
22-18	Vendor revision number
17	Trellis coding option
16	Echo cancelling option
15	Expanded exchange sequence
14	Support of higher bit rates
13	Support of dual latency downstream
12	Support of dual latency upstream
11	Network timing reference
10-9	Framing structure
8-4	Reserved for future use
3-0	Maximum numbers of bits per sub-carrier supported

NOTES

1. All bits “reserved for future use” shall be set to 0 until defined.
2. Within the separate fields the least significant bits have the lowest subscripts.
3. Bits 25-18 shall be copied in the Revision Number eoc register (see 8.1.4).

9.7.6.1 Vendor identification - Bits 43 - 28

The vendor ID is coded in binary. The currently assigned vendor IDs are listed in Annex D. Others may be added in the future.

9.7.6.2 T1.413 revision number- bits 25 - 23

For ATUs complying with ANSI T1.413 Issue 2, the revision number shall be coded {001}.

NOTE - This is consistent with the three most significant bits of the version number of a ANSI T1.413 Issue 1 ATU being set to {000}.

9.7.6.3 Vendor revision number- Bits 22-18

The version number is encoded as defined in 9.6.4.4.

9.7.6.4 Trellis coding option - Bit 17

$m_{17} = 0$ indicates no trellis coding capability; $m_{17} = 1$ indicates trellis coding capability.

9.7.6.5 Echo cancellation option - Bit 16

$m_{16} = 0$ indicates no echo cancellation; $m_{16} = 1$ indicates echo cancellation.

9.7.6.6 Extended Exchange Sequence - Bit 15

The extended exchange sequence shall be enabled (bit 15 = 1). The extended exchange sequence shall be used if and only if both ATUs indicate bit 15 = 1.

9.7.6.7 Support of higher bit rates - Bit 14

m_{14} = 1 indicates the ATU-R supports higher bit rates option (i.e., *S*=1/2 with 2 RS codewords per DMT symbol); m_{14} = 0 indicates the ATU-R does not support this option.

9.7.6.8 Support of dual latency downstream - Bit 13

m_{13} = 1 indicates the ATU-R supports dual latency downstream; m_{13} = 0 indicates the ATU-R does not support dual latency downstream.

9.7.6.9 Support of dual latency upstream - Bit 12

m_{12} = 1 indicates the ATU-R supports dual latency upstream; m_{12} = 0 indicates the ATU-R does not support dual latency upstream.

9.7.6.10 Network timing reference - Bit 11

m_{11} = 1 indicates the ATU-R supports reconstruction of the network timing reference from the downstream indicator bits 23-20.

9.7.6.11 Framing structure - Bits 10-9

Indicates the highest framing structure supported by the ATU-R (see 7.4). The lowest framing structure indicated by the ATU-C or ATU-R shall be used.

9.7.6.12 Maximum numbers of bits per sub-carrier supported - Bits 3-0

The N_{upmax} (transmit) capability is encoded onto $\{m_3 \ldots m_0\}$ with a conventional binary representation (e.g., 1101 = 13)

> NOTE - The maximum number of bits for the downstream data, $N_{downmax}$, that the ATU-R receiver can support need not be signaled to the ATU-C; it will be implicit in the bits and gains message, R-B&G, which is transmitted after channel analysis.

9.7.7 R-CRC2

R-CRC2 is a cyclic redundancy check for detection of errors in the reception of R-MSGS1 at the ATU-C. The CRC generator polynomial is as defined in 9.7.5. The CRC message polynomial is as constructed in 9.7.5, with m_0 corresponding to a_0 and m_{47} corresponding to a_{47}. The CRC check polynomial is generated in exactly the same way as described in 9.7.5. These 16 bits are transmitted in 16 symbol periods using the method described in 9.7.5. Following R-CRC2, the ATU-R shall enter state R-MEDLEY.

9.7.8 R-MEDLEY

R-MEDLEY is a wideband pseudo-random signal used for estimation of the upstream SNR at the ATU-C. The data to be transmitted are derived from the pseudo-random sequence PRU defined in 9.5.2. In contrast to R-REVERB1, however, the cyclic prefix is used and the data sequence continues from one symbol to the next (i.e., d_1-d_6 are not re-initialized for each symbol). Because the sequence is of length 63, and 64 bits are used for each symbol, the sub-carrier vector for R-MEDLEY changes from one symbol period to the next. The pilot sub-carrier is over-written by the {+,+} constellation point.

Although data bits are defined for all the sub-carriers, the sub-carriers actually transmitted during R-MEDLEY shall be the same as or a subset of those transmitted during R-REVERB1 (see 6.15.1).

R-MEDLEY is transmitted for 16384 symbol periods. Following R-MEDLEY the ATU-R enters signaling state R-REVERB4.

9.7.9 R-REVERB4

R-REVERB4 is the same as R-REVERB3 (see 9.7.2). The duration of R-REVERB4 is 128 symbols. This signal marks the end of channel analysis, and R-SEGUE3 immediately follows R-REVERB4.